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REPORT

ON

A STUDY OF WESTERN YELLOW PINE

LINE SLASH DISPOSAL METHODS IN

THEIR RELATION TO INSECTS

By

Hubert L. Person
Assistant Entomologist
U. S. Bureau of Entomology
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Approved _____

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6 Copy sent J. M. Miller 1/18/28.
1 " " Mr. Person.

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REPORT ON A STUDY OF WESTERN YELLOW PINE LINE SLASH DISPOSAL METHODS IN THEIR RELATION TO INSECTS

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Introduction

It has been fairly well established that, in general, western yellow pine slash is not a serious menace as a breeding ground for primary forest insects. Nevertheless there are many special entomological problems in connection with slash disposal that require further study. The disposal or treatment of line slash cut in clearings for power lines, roads, etc. is one such problem.

The Forest Service has carried in all clearing contracts on National Forest lands the provision that all slash should be disposed of in a manner that would prevent the possibility of the debris serving as a breeding ground for bark beetles that may subsequently attack standing trees. As the result of studies recently completed by the Bureau of Entomology there has been some question as to how far the Forest Service should go in their demands on those responsible for the treatment of the slash.

This problem was recently brought to our attention by the District Office of Forest Management in connection with the Great Western Power Company clearing between Pulga and

Storrie, California. In this case the contract called for the disposal of all slash as specified by the Forest Service. The trees were cut in the fall of 1926 and the brush burned during the winter. Early in 1927 the supervisor on the forest on which the trees were cut reported that a number of the logs had been left unpeeled and it was thought that they might serve as a breeding ground for destructive barkbeetles. In order to protect the government timber the company was asked to guarantee treatment of any infested trees that might be attacked as a result of this clearing.

Miller and Dunston examined the area on April 7, 1927 and found that most of the logs had been well charred by the burning of the limbs and brush over them. The principal question was how much infestation would develop in the bark areas which were not charred and whether or not such infestation would menace nearby standing timber. It also emphasized the need for further study to develop slash disposal methods which would not only prevent harm to the surrounding timber from the slash insects but might even prove beneficial by reducing the beetle population of an area.

Funds and men were not available for a complete study of the problem but as a start Miller outlined the following experiment which was carried out by Person in cooperation with the Forest Service and the Southern California-Edison Company. The Bureau of Entomology paid the salaries and the Forest Service paid the field expenses and also reimbursed the

Southern California-Edison Company for treating the slash as directed.

Location of study

The experiment, upon the suggestion of Supervisor Benedict, was located on the new Southern California-Edison Company power line right-of-way between Big Creek and José Basin on the Sierra National Forest. The area includes about one-half mile of right-of-way where it runs through a pure, fairly open, yellow pine stand of about a poor Site III. The general exposure is northerly but the area lies along a draw so that all exposures were found.

Methods

Five different methods of treatment were tried as follows:

Group I - Six trees were felled only. The limbs and bark were left undisturbed. This created a condition such as results where no particular method of disposal is employed and served as a check against the other methods used.

Group II - Six trees were felled and the limbs cleared away leaving the trunk exposed for its full length.

Group III - Six trees were felled, limbed and the trunk covered with brush.

Group IV - Six trees were felled, limbed, covered with brush and burned within about two weeks from the time of felling.

Group V - a. Four trees were felled, limbed and the lower one-half of the trunk covered with brush. The upper half was left exposed.

b. Two trees were felled, limbed and the lower half covered with brush and burned.

The trees were all cut and treated between April 20 and May 20 so that they would be subject to attack during the first flight periods of both Ips confusus and Dendroctonus brevicomis. Any parts not attacked during the first flight periods would be subject to attack by beetles in flight all through the summer.

The diameter, total height and length of crown, direction felled, exposure, slope and amount of shade from other trees are given by trees in Table 1.

At least two different exposures were used in each group and the trees were felled so that half of the trees in each group would lie approximately north and south and half east and west.

Table 1.

Data on trees used in experiment

	Group I						Group II						Group III						Group IV						Group V					
Tree number	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
D.B.H. (inches)	26	30	16	24	20	24	26	24	20	22	20	34	18	22	24	24	24	22	24	22	26	24	22	22	18	20	22	20	18	18
Height (feet)	130	130	110	130	120	120	120	120	110	100	90	120	90	80	120	120	110	90	100	90	110	110	80	80	100	100	100	110	80	80
Crown length (ft)	80	90	80	80	80	100	Not taken						- -						- -						- -					
Direction felled	E	E	NE	NE	NE	SW	NE	N	N	S	N	SE	W	N	N	N	W	NW	S	E	S	S	W		N	N	N	W	W	W
Exposure	W	W	E	E	E	L	W	W	W	N	NE	S	NE	SE	SE	SE	E	S	SE	S	N	N	E	E	E	E	E	S	S	S
Slope	20	20	20	20	20	0	20	15	15	10	10	10	5	10	10	15	15	15	5	5	15	15	10	20	20	20	20	15	10	15
Shade from other trees in percent	5	5	0	15	25	0	0	0	0	0	0	0	0	0	0	5	0	0	5	5	0	5	0	5	5	0	0	5	0	0

Examinations

During the summer the trees were examined on May 12, May 25, and July 21. The purpose of these examinations was to note the time of attack by the different insects and also their rate of development.

The final examination was made on October 1 by Person, assisted by Wagner. At that time, a detailed examination was made to determine the amount of each tree infested by each of the insects found, the condition of the brood or the emergence for each insect and conditions under the bark affecting brood development. To obtain this data, a careful study was made of a strip one foot wide and extending around the trunk at every 10-foot interval on all of the trees. The amount of strip attacked by each of the insects was determined as well as data on the attacks and brood development or emergence. For the western pine bark beetle, counts were made to determine the actual number of attacks and the emergence for each strip. This was not possible with the other insects so only general data were taken to show the abundance of attacks and brood or the relative amount of emergence.

On the basis of the strip counts, supplemented by a more extensive examination of each log, the total area infested by each insect and also the percent fire injured and green was determined for each log.

The results are given in Table 2. A graphic presentation is given in Fig. 1.

Principal insects found

The western pine beetle, (D. brevicomis), was the only insect found in the logs that is strictly a primary forest insect. The engraver beetle, (Ips confusus), is only occasionally primary. It is a typical slash insect which at times kills reproduction or pole stands and the tops of larger trees.

The buprestids include two or more species of flat-headed borers; Melanophila gentilis and M. californica are the most common. These borers are purely secondary insects and rarely, if ever, kill healthy western yellow pine trees, though they occasionally kill weakened trees.

The cerambycids or round-headed borers are principally of two species, Graphisurus spectabilis and G. obliquus.

These borers are never primary and in many cases are probably beneficial through reducing the broods of D. brevicomis by robbing them of their food.

From the above, it is seen that the western pine beetle is the most important primary insect found in the slash and that the engraver beetle is the only other insect breeding in the slash that needs to be considered as a menace to the surrounding timber.

Table 2.

Total bark surface with per cent infested
by each insect, per cent scorched and per cent green on October 1.

Tree number	Group I							Group II							Group III							Group IV							Group V						
	1	2	3	4	5	6	Average or Total	1	2	3	4	5	6	Average or Total	1	2	3	4	5	6	Average or Total	1	2	3	4	5	6	Average or Total	1	2	3	4	5	6	Average or Total
																													Burned 0 - 40'			Burned 0 - 55'			
Total bark surface in square feet	460	532	242	425	328	394	2381	426	394	302	304	250	558	2234	225	246	394	394	563	275	1897	331	275	393	363	246	246	1854	248	276	304	302	201	201	1532
Percent with D. brevicomis	44	34	4	21	18	10	25	40	18	20	23	28	40	30	0	40	50	40	60	10	38	0	0	3	3	15	5	4	Butt 0 Top 0	40 10	30 5	23 23	0 0	5 0	16 6
Percent with Ips confusus	20	26	60	45	40	75	45	0	12	10	12	22	0	8	30	20	20	15	15	70	27	0	5	7	7	5	10	6	Butt 0 Top 0	0 5	30 0	0 0	70 20	60 15	27 7
Percent with Buprestids	16	30	25	20	35	10	20	25	30	60	45	50	20	38	0	10	10	10	0	0	5	50	15	70	70	60	35	50	Butt 30 Top 30	0 20	0 35	40 25	0 10	0 20	12 23
Percent with Cerambycids	0	10	5	5	7	5	5	5	20	10	0	0	10	7	0	30	20	35	25	0	15	10	5	5	5	10	10	8	Butt 10 Top 5	10 15	0	0	0	0	3+ 3+
Percent with cambium scorched																						40	75	15	15	10	40	32	15			12			4
Percent green	20	0	6	9	0	0	5	30	20	0	20	0	30	17	70	0	0	0	0	20	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Areas attacked by the different insects

Each of the four main groups of insects considered require a certain set of conditions for their best development. D. brevicomis and I. confusus are more nearly alike in their requirements than any of the others but because of a difference in their life histories they are usually found on different parts of the slash. The engraver beetle's first attack is early in the season when the temperatures are low and so is often found on the tops and upper sides of logs with little or no shade. The lower sides of the logs and all of the heavily shaded areas were avoided by the first Ips attacking. By the time the D. brevicomis start to attack conditions are usually too hot on the exposed or lightly shaded areas and so most of the D. brevicomis attacks were made on the bottom or lower sides of the exposed logs or on any part of the shaded logs except where conditions were too moist.

The buprestids are usually found along the tops of the logs where exposed to full sunlight. They are able to withstand temperatures which would be fatal to other insects.

The cerambycids are the last to attack and favor partially or fully shaded areas or the under sides of logs. They are commonly found associated with D. brevicomis and Ips but they are apparently able to develop in colder, more moist situations than either Ips or D. brevicomis.

Time of attack of the different insects

The first insect to attack was the engraver beetle. It started to attack soon after the first trees were felled on April 20. By May 12, when next examined, there was a good attack with eggs and small larvae on a number of the trees. On May 25, some of the broods had reached the pupal stage and emergence must have started early in June. By July 25, emergence from the first attacks had been completed.

The first attacks by the western pine beetle were made on about May 15 to 20. On May 25, the broods had started to develop and first emergence started about July 15. Scattered attacks were made throughout most of the summer and were still being made when the slash was last examined on October 1.

The buprestids started egg laying about May 12. By July 20, the larvae were one-half to full grown and on October 1, they had reached the prepupal stage.

The cerambycids were the last of the insects to start work on the slash. As no larvae were noticed on July 21 egg laying must have started some time during July, probably about the middle of the month. When the slash was examined on October 1, the larvae were from one-half to nearly full grown.

Brood development

As all of the important insects found, with the exception of D. brevicomis, are secondary insects which find their best conditions for development in freshly killed

material, it would be expected that brood development would be good in much of this slash. While no counts were made on the secondary insects, it was apparent from the examinations made that in general the brood development of the secondary insects was good.

Brood development of D. brevicomis

The brood development or potential of the western pine beetle was determined by sample counts of the number of attacks and the emergence at each 10-foot interval on all of the logs.

The results of these counts are given in Table 3. On the average, there are about two D. brevicomis adults to each attack so the number of attacks was doubled to give the number of beetles attacking as given in the table. The results as presented in this table, are shown graphically in Fig. 2, in comparison with the average number of beetles attacking and emerging from standing trees. The standing tree figures on number of beetles attacking and emerging are the averages for seven trees, on the Cascadel area of the Sierra National Forest, killed during the summer of 1927. Counts were made on strips around the trunk at every 10-foot interval on each of the seven trees.

The results show that the western pine beetle is quite sensitive to the condition of its host. It is evident, from this study as well as from other studies made by a number of western workers, that slash rarely offers conditions as favorable for the development of D. brevicomis

Table 3.

Relation of attack to emergence, D. brevicomis

Group	Tree number	Number of square feet infested by D. brevicomis	Number of D. brevicomis per square foot Attacking	Emerging	Increase or decrease + or -
I	1	202	16	10	6-
	2	180	24	30	6+
	3	10	10	10	0
	4	90	18	29	11+
	5	60	28	23	5-
	6	40	10	20	10+
	Total	582	Average 19.7	22.3	Average 2.6+ per square foot
II	1	170	16	0	16-
	2	70	10	5	5-
	3	60	10	3	7-
	4	70	16	0	16-
	5	70	12	3	9-
	6	220	14	4	10-
	Total	660	Average 13	2.5	Average 10.5- per square foot
III	1	0	-	-	-
	2	100	16	3	13-
	3	200	16	12	4-
	4	160	10	8	2-
	5	220	10	6	4-
	6	30	10	0	10-
	Total	710	Average 12.4	7.5	Average 4.9- per square foot
IV	1	0	-	-	-
	2	0	-	-	-
	3	12	10	10	0
	4	11	10	10	0
	5	37	6	0	6-
	6	12	6	0	6-
	Total	72	Average 7	3	Average 4- per square foot
V	1	0	-	-	-
	2	138	10	0	10-
	3	106	10	0	10-
	4	70	10	0	10-
	5	0	-	-	-
	6	10	6	0	6-
	Total	324	Average 10	0	Average 10- per square foot

broods as standing trees.

The trees of Group I that were felled only provided the most favorable conditions of any of the treated groups. There are two probable explanations for this: (1) the limbs being left on the trees provided shade enough to prevent sun curing on the tops of the logs and so kept the temperature favorable for the broods, and (2) as the crown was left intact, the needles continued to transpire and so prevented a too moist or sour sap condition under the bark. It was observed that the moisture condition of the cambium of the trees of this group was apparently quite favorable except on parts of the large butts.

The conditions for brood development on the trees of Group II were decidedly unfavorable, resulting in a greater reduction in D. brevicomis population than in any of the other groups. The mortality or lack of development on the tops of the logs was probably the result of "sun curing" due to exposure to the direct rays of the sun. A large part of the cambium on the remainder of the logs was excessively moist and "sour sap" condition was common. This resulted from the lack of any means of evaporation or transpiration.

Unfavorable conditions on the Group III trees were due principally to excessive moisture.

On the Group IV trees, a large percent of the bark on the bottoms and sides was burned off and conditions were

so dry and hot on the tops that the buprestids were the only insects that could rear a brood.

The Group V trees showed a combination of conditions found in II, III and IV.

The lack of any "breeding up" of the western pine beetle is clearly shown. Even in Group I, where the trees were felled only, the increase in effective progeny of only 2.6 beetles per square foot would be more than offset by mortality during flight. It is evident that the potential of beetles attacking standing trees is so much greater than that of the beetles that attacked the slash that any effect on the total infestation would be on the side of a decrease rather than an increase.

The trees in all the other groups showed an actual decrease in the number of beetles emerging over the number that attacked. In Group II, the average number of beetles emerging per square foot was 10.5 less than the number that attacked, and the other three groups showed a decrease of from three to nine per square foot.

In Fig. 3 the average figures for attack and emergence per square foot for each group have been multiplied by the total number of square feet attacked by D. brevicomis to give the total effect of the slash. It is evident from this graph, together with the other data presented, that line slash under the conditions of this

experiment is never a serious menace, - considering only the western pine beetle, - regardless of how it is treated. But, more important, it shows that with a little care it may be so handled as to bring about an appreciable reduction in the beetle population of an area.

Importance of I. confusus

The engraver beetle, Ips confusus, is the only other insect found in this slash which might become primary. There are occasionally outbreaks of this insect either as a result of the concentration of beetles in one area due to some strong attraction or as a result of breeding up under conditions unusually favorable for the beetle. Although outbreaks by this insect are usually of short duration and the damage confined to pole stands and to top killing of larger trees, any system of slash disposal which would be least favorable for this insect should be given a preference.

Referring again to Fig. 1, it will be seen that the trees in Group II and Group IV had less than eight per cent of the area attacked by Ips. As these two groups also show a pronounced minus potential for D. brevicomis (See Fig. 2 and 3) the methods used in these two groups will probably give the best results in conditions similar to those found in this experiment.

Adaptability of methods recommended to management practice

The Forest Service regulations now in force in regard to line slash call for the burning of all pieces of slash less than four inches in diameter. Wherever it is

considered advisable, special treatment of slash may be demanded to prevent damage to the surrounding timber by insects which breed in the slash. Consequently, no difficulty will be encountered in applying any of the slash disposal methods tried.

The two best methods of disposal are number II, which calls for falling and limbing all the trees and leaving the trunk exposed, and IV which calls for falling, limbing, covering the trunk with brush and burning. In cases where the burning can be completed within one month of falling, the number IV method is probably best. If a large percent of the cambium of the logs is scorched, this method would be effective even on north slopes and in shaded situations where method II would not be so effective. The greater the percent of the cambium scorched, the more effective the method.

Method II is best suited to open situations where the logs can be exposed to full sunlight; and especially where the slash is not to be burned within a month from the time the trees are felled. The reason for this is that it takes about a month or more for the D. brevicomis and I. confusus broods to develop and emerge. If, where the brush is piled on the trunks, the broods complete their development before the logs are burned, the effect would be the same as for method III. A study of the three Figures 1, 2, and 3, will show that it would be much better, considering both

D. brevicomis and I. confusus, to leave the logs exposed as in method II.

Need for further study

The slash problem is far from solved. It is an involved problem which will require a great amount of detailed study before we will know what we need to know about the effect of slash on insect infestations.

The study just completed opens up a number of leads which may be profitably followed. A repetition of this study using trees cut in all seasons of the year and on a wide variety of sites and exposures would do much to solve the practical side of the problem. But more could be learned by the use of detailed ecological methods. This would require the studying of all the factors which affect the development of cambium feeding insects in slash under a wide variety of conditions.

SUMMARY

It has been found that, in general, yellow pine slash is not a serious menace as a breeding place for primary forest insects. But, the large amount of line slash being cut in clearing rights-of-way for roads, power lines, trails, etc. has brought up the need for further study of slash disposal methods as they affect the line slash-insect problem. It is not enough to know that, in general, slash is not a serious menace from the insect standpoint. We should know what slash disposal method is most beneficial to the forest under any set of conditions.

A start toward the solution of the problem has been made by the study of insect development in line slash treated according to five different methods. The experiment was limited to trees cut in the lower western yellow pine belt of California, during April and May.

Four insects or insect groups attacked the felled trees during the first season:

1. The western pine beetle, D. brevicomis.
2. The confused engraver beetle, Ips confusus.
3. Flatheaded borers, Melanophila spp.
4. Rounded borers, principally Graphisurus spectabilis.

Of these, the western pine beetle is the only typically primary forest insect and so is of most importance. I. confusus, which is occasionally primary, is the only other insect that needs to be considered in this study.

The five methods of disposal tried and the results of each follow:

I. Trees felled only, limbs and bark left intact.

25 percent of bark area was attacked by D. brevicomis.

Brood development was better than in any of the other slash groups but much poorer than in standing trees.

D. brevicomis emergence greater than number attacking by 2.6 beetles per square foot.

Fair to good I. confusus brood developed on 45 percent of the bark area.

II. Trees felled and limbs cleared away leaving the trunk exposed.

30 percent of the bark area attacked by D. brevicomis.

Brood development very poor.

D. brevicomis emergence less than number attacking by 10.5 beetles per square foot.

Only 8 percent of the bark area attacked by I. confusus.

III. Trees felled, limbed and covered with brush.

38 percent of the bark area attacked by D. brevicomis.

Brood development better than in group II but poorer than in group I.

D. brevicomis emergence less than number attacking by 4.9 beetles per square foot.

Fair I. confusus brood developed on 28 percent of the bark area.

IV. Trees felled, limbed, covered with brush and burned.

32 percent of the cambium area scorched. Most of the rest of the bark area unfavorable for bark beetle development.

4 percent of the bark area attacked by D. brevicomis with emergence less than the number attacking by 4 beetles per square foot.

6 percent of the area attacked by I. confusus.

V. Trees felled and limbed and lower one-half of trunk covered with brush or covered and burned.

Burned and exposed parts had very little bark-beetle work; covered parts too moist for brood development.

22 percent of bark area attacked by D. brevicomis with emergence less than number attacking by 10 beetles per square foot.

Fair I. confusus brood developed on 33 percent of the bark area.

Recommendations

Either method II or method IV are recommended for most situations. They combine a high brood mortality of D. brevicomis with a small percent of area attacked by I. confusus and so would probably improve the forest insect condition in an area rather than create a menace.

Method II, in which the trees are felled and limbed only, should be used when burning of the slash could not be completed within a month from the time the trees are felled. It is most effective on open sites where the logs can be exposed to full sunlight.

Method IV, in which the trees are felled and limbed and the brush burned over the trunks, is the surest method when the burning can be completed within a month after the trees are felled (i.e. before the broods have a chance to develop

and emerge); especially on north slopes and in shaded situations where the logs cannot be exposed to direct sunlight.

FIG. I

ANALYSIS OF INFESTATION

BY SLASH GROUPS

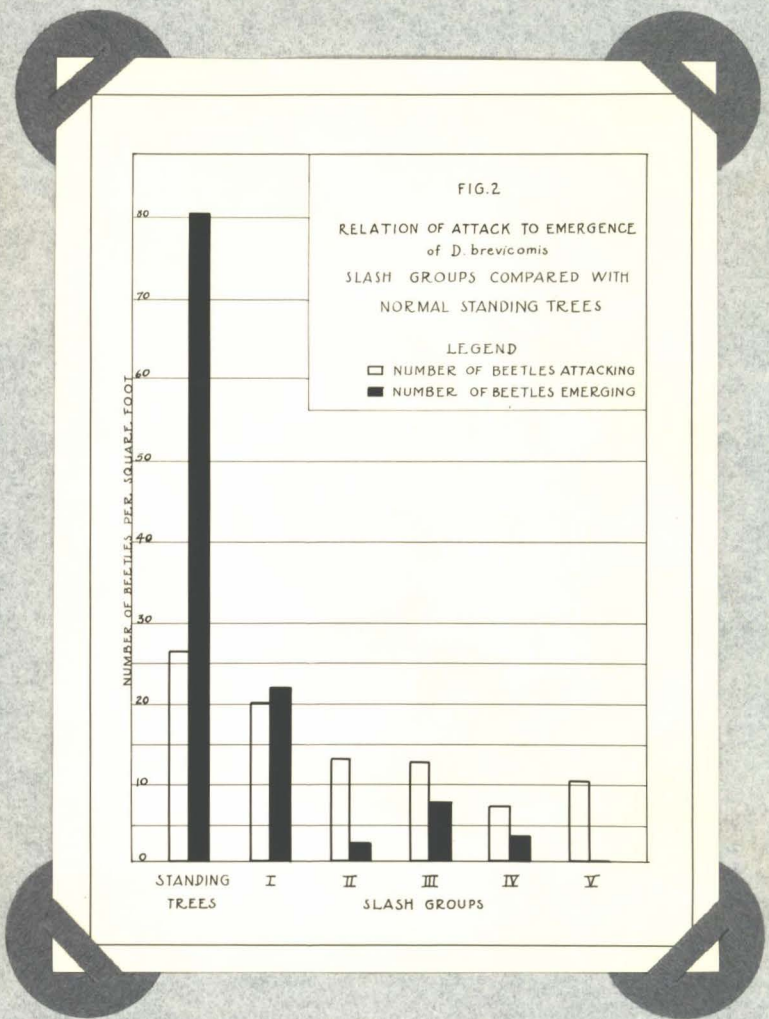
FIG. 2
RELATION OF ATTACK TO EMERGENCE
of D. brevicomis
SLASH GROUPS COMPARED WITH
NORMAL STANDING TREES
LEGEND
NUMBER OF BEETLES ATTACKING
NUMBER OF BEETLES EMERGING
NUMBER OF BEETLES PER SQUARE FOOT
80
70
60
50
40
30
20
10
0
STANDING TREES
I
II
III
IV
V
SLASH GROUPS

FIG. 3

RELATION OF ATTACK TO EMERGENCE

of D. brevicomis

COMPARISON OF DIFFERENT SLASH DISPOSAL METHODS